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Effects of Conditioning Voices as Reinforcers for Listener Responses on Rate of Learning, Awareness, and Preferences for Listening to Stories in Preschoolers With Autism

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We used a delayed non-concurrent pre- and post-intervention probe design to test the effects of a voice conditioning protocol (VCP) with 3 preschoolers with autism on (a) rate of acquisition of listener curricular objectives, (b) observing voices and the presence of adults across 3 settings, (c) selecting to listen to adults tell stories in free play setting, and (d) the occurrence of stereotypy in the story setting. The VCP conditioned voices as reinforcers for listening to recordings of voices via stimulus-stimulus pairing, which resulted in the children listening to audio recordings of voices in 90% of intervals in 5-min concurrent-operant preference tests. After voices became conditioned reinforcers, all 3 children's learning accelerated; 2 children's observing responses increased in the 3 settings; and 2 children selected to listen to stories and also showed decreased stereotypy in the story setting. The data suggest that conditioned reinforcement for observing responses may be a verbal behavior developmental cusp that acts to accelerate learning that involves listening, and that the cusp may be induced using the VCP.

In this experiment we tested the utility of conditioning voices as reinforcers for listening on (a) acquisition of curricular objectives; (b) attention to, or awareness of, the presence of adults and their voices; (c) preferences for listening to stories in a free-play setting; and (d) emission of stereotypy in the story setting. From a theoretical perspective, the experiment addresses the verbal behavior developmental theory (VBDT) position that conditioned reinforcement for attending to voices is a developmental cusp that makes it possible for children to learn from instruction (Greer & Ross, 2008; Greer & Speckman, 2009). From an applied perspective, the experiment tests a procedure for its usefulness in making it possible for children with severe delays to accelerate learning, choose to listen to adults tell stories in a free play setting, and acquire awareness of adults in their environment.

According to the VBDT, the presence of prerequisite and co-requisite behavioral developmental cusps makes it possible for children to make contact with the instructional benefits of environmental experiences. Rosales-Ruiz and Baer (1996) introduced the notion that behavioral developmental cusps enable children to learn new operants because the new behavioral cusps allow the children to get in touch with the contingencies that follow contact with new aspects of their environment. The newly acquired cusp results in the ability to learn what a child could not learn before and accelerates the establishment of new stimulus control (Greer & Keohane, 2005; Greer & Ross, 2008; Greer & Speckman, 2009).

Developmental cusps may also include the establishment of conditioned reinforcers for observing responses (Keohane, Pereira-Delgado, & Greer, 2009). Studies on the effects of conditioning reinforcers for observing responses have reported accelerated learning of responses associated with the newly conditioned reinforcers for observing responses (Dinsmoor, 1983; Keohane, Luke, & Greer, 2008; Keohane et al., 2009; Pereira-Delgado, Greer, Speckman, & Goswami, 2009; Tsai & Greer, 2006). The observing responses are new operants (Holland, 1958) and these new operants make it possible to acquire discriminative stimulus control that was previously difficult if not impossible to attain.

Some current theories of verbal behavior suggest that ''to be truly verbal,'' listener and speaker repertoires must be joined such that children have naming (Horne & Lowe, 1996; Greer, Stolfi, Chavez-Brown, Nirgudkar, & Rivera-Valdes, 2005; Greer, Stolfi, &

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Pistoljevic, 2007; Pistoljevic, 2008), self-talk conversational units (Lodhi & Greer, 1989), and say-do correspondence (Paniagua & Baer, 1982). While these recent expansions of Skinner's (1957) theory incorporate greater attention to the listener than Skinner did in his initial analysis, Skinner's notion that verbal behavior often requires behaving simultaneously as both listener and speaker was also implicit in his initial thesis. The VBDT proposes that the learning and developmental processes leading to the intercept of the initially independent speaker and listener repertoires requires acquisition of separate speaker and listener cusps. These are foundational cusps that must be present if the listener and speaker repertoires are to be joined (Greer & Keohane, 2005; Greer & Ross, 2008; Greer & Speckman, 2009; Keohane et al., 2008).

One of the key developmental cusps that would appear to be necessary, even before what is spoken has a listener function, is the capacity to be reinforced for attending to voices. Research with young typically developing and sensorially intact infants reported that the voices of mothers are a conditioned reinforcer for observing at birth (DeCasper & Spence, 1987). These data propose that the conditioning process occurred in the uterus. In other words, the mother's voice is paired with feeding in the uterus, which conditions the mother's voice as a reinforcer for listening (DeCasper & Spence, 1987). The mother's voice then selects out the infant's attention and the infant responds to her voice significantly more than a stranger's voice (DeCasper & Spence; Ockleford, Vince, Layton, & Reader, 1988). This pairing may not occur or may be defective in some children.

Typically developing children acquire aspects of their parents' language without special instruction or direct reinforcement (Bijou & Baer, 1965; Hart & Risley, 1995; Moerk, 1990; Mowrer, 1954; Novak, 1996; Schlinger, 1995). Some suggest that such incidental learning is traceable to automatic reinforcement for emitting speech that corresponds to what the child hears spoken (Skinner, 1957; Vaughan & Michael, 1982). Of course, the sound of what is spoken by the child can only automatically reinforce her/his speech if attending to the voice of adults is a conditioned reinforcer for observing or attention to voices. This is thought to occur naturally as a result of the pairing of the voice with an established form of reinforcement as proposed by Schlinger (1995).

For more than four decades, stimulus-stimulus pairing procedures have been successfully used to expand the pool of stimuli that function as reinforcers for behavior or an individuals' community of reinforcers, by teaching children to prefer previously non-preferred stimuli via stimulus-stimulus pairings (Greer, Becker, Saxe, & Mirabella, 1985; Greer, Dorow, & Hanser, 1973; Greer, Dorow, Wachhaus, & White, 1973; Keohane et al., 2008; Longano & Greer, 2006; Nuzzolo-Gomez, Leonard, Ortiz, Rivera, & Greer, 2002; Pereira-Delgado et al., 2009; Tsai & Greer, 2006). Existing evidence appears to affirm the role of conditioned reinforcers as a behavioral explanatory construct (Williams, 1994).

Research on stimulus-stimulus pairing to condition reinforcers in experimental analyses in applied settings can be separated into two categories, with the conditioned reinforcement as either (a) the dependent or (b) independent variable. When conditioned reinforcement has been treated as the dependent variable, stimulus-stimulus pairings have been used to condition books as reinforcers for observing responses, previously non-preferred music as a newly conditioned reinforcers for choice responses (Greer, Dorow, Hanser, 1973; Greer, Dorow, Wachhaus, et al., 1973; Greer, et al., 1985), books as reinforcers for observing responses in free play, or toys and computer screens as reinforcers for observing (Longano & Greer, 2006; Nuzzolo-Gomez, et al., 2002). Sundberg, Michael, Partington, and Sundberg (1996), Yoon (1998), and Yoon & Bennett (2006) also reported that pairing preferred stimuli with hearing vocal sounds emitted by adults resulted in increases in children emitting parroting responses (Skinner, 1957) in free play settings.

In some of the studies (Greer, et al. 1985; Longano & Greer, 2006; Nuzzolo, et al. 2002), the newly conditioned reinforcers for play or observing responses also resulted in significant decreases in, or elimination of, stereotypical behaviors in free play. This led the authors of these papers to suggest that

building new reinforcers results in the new reinforcers displacing automatic reinforcers for stereotypy for some children, since the newly conditioned reinforcers resulted in allocation of responding to the new reinforcers rather than the emission of stereotypy (Greer et al., 1985; Nuzzolo-Gomez, et al., 2002).

Other experiments have treated the acquisition of conditioned reinforcement as an independent variable. This research has built upon the foundation of stimulus-stimulus pairing, using the procedure to induce conditioned reinforcers for observing responses that are related to instruction. These studies reported accelerated rates of learning of tasks that involved visual and textual stimuli (Pereira-Delgado et al., 2009; Tsai & Greer, 2006) and discriminated responding in pigeons (Dinsmoor, 1983) as a function of acquisition of conditioned reinforcers for related observing responses. In these experiments, the acquisition of conditioned reinforcers was the independent variable (i.e., the stimulus-stimulus procedures was a means to induce conditioned reinforcers), and the effects of newly conditioned reinforcers for observing responses on rates of learning served as the dependent variable.

According to verbal behavior developmental theory, when the cusp of phonemic control is missing, the child lacks basic listener literacy (Greer, Chavez-Brown et al., 2005). Basic listener literacy or phonemic awareness is defined as responding discriminatively to two or more different vowel-consonant combinations (Crystal, 2006). Greer et al. demonstrated that eight children who lacked the basic listener cusp (i.e., the children did not respond accurately to vocal instructions) could be taught to do so in a procedure that involved an intensive immersion in listener instruction. However, for this protocol or instruction in listener responding to be successful, it is possible that voices, as conditioned reinforcers need to be present.

We tested whether the acquisition of voices as conditioned reinforcers would result in increases in observation of others, accelerate learning of educational goals that require listener responding, and increase choosing to listen to stories in a free play setting.

METHOD

Participants and Setting

Three preschool-age children diagnosed with autism spectrum disorders served as participants. All 3 participants were selected from the population of a publicly funded and privately run preschool for children with and without developmental delays. The school employed a behavior-analytic approach to all teaching, curriculum, and behavior management (Greer, 1994; Greer, Keohane, & Healy, 2002; Lamm & Greer, 1991; Selinske, Greer, & Lodhi, 1991). The participants were selected for this study because their behavior was not under vocal verbal control and they required extensive numbers of instructional trials to master educational objectives for vocally presented stimuli (e.g., following one step vocal directions, responding to their names, ''point to'' instruction with various stimuli, match-to-sample-instruction)

All three participants functioned at prelistener and pre-speaker levels of verbal behavior (Greer, 2002; Greer & Keohane, 2005; Greer & Ross, 2008; Skinner, 1957). That is, they lacked listener literacy (responding differentially to two or more different vowel-consonant combinations) and lacked vocal-verbal or systematic sign functions; however, they emitted incipient gestural mands. Participants A, B, and C were: a male aged 5 years 2 months; a female aged 5 years 5 months; and a male aged 4 years 7 months, respectively. Table 1 contains detailed descriptions of each participant's standardized test scores, and their repertoires at the time of this study. Assessment instruments included the *Vineland Adaptive Behavior Scales*, either the Interview (1984) or Classroom Editions (1984), *The Preschool Language Scale* (Zimmerman, Steiner, & Pond, 2002), and *The Bayley Scales of Infant Development—Second Edition* (Bayley, 1993). These assessments were conducted by psychologists in the students' referring school districts, prior to the students receiving instruction in the school, and therefore, instruments varied across students. In addition, the students' repertoires were assessed directly in the school using *The CABAS® International Curriculum and Inventory of Repertoires For Children from*

Table 1
Description of Participants

Participant	A	B	C
Bayley II	Mental development index: 70	Mental development index: 60	Cognitive: 60 Language: 53 Social emotional: 55
PLS-4	Total language: 50	Not administered	Total language: 50
Vineland	Adaptive composite: 65	Adaptive composite: 58	Adaptive composite: 76
Diagnosis	Autism	Autism	Autism
Verbal	Pre-speaker	Pre-speaker	Pre-speaker
Capabilities	Pre-listener	Pre-listener	Pre-listener
PIRK skills in repertoire	Gestural mands Follow directions with visual cues Visual-visual match to sample (MTS) Motor imitation Imitate actions with objects	Gestural mands Follow directions with visual cues Visual-visual MTS Motor imitation Imitate actions with objects	Gestural mands Follow directions with visual cues Visual-visual MTS Motor imitation Imitate actions with objects

Note. For the Bayley II, PLS-4, and Vineland standard scores are given.

Pre-School through Kindergarten (Greer & McCorkle, 2003; Waddington & Reed, 2009). This is a criterion-referenced curriculum and repertoire assessment tool that identifies and assesses the repertoires needed from preschool through first grade. It is continuously updated for each child in the school and closely monitors the children's levels of achievement and the stimuli that function as reinforcers for them. The children's verbal behavior achievement levels and standardized measures, as reported in Table 1, represent levels at the onset of the experiment that continued across approximately four months.

All parts of the study were conducted in the students' classrooms, at the table or in the toy area, while other students were engaged in regular instruction. One or two sessions were conducted daily.

Dependent Variables

We measured four dependent variables prior to and following the implementation of a voice conditioning protocol (VCP). The dependent variables included: (a) rate of acquisition of listener instructional objectives, (b) observing responses to voices and adult presence across three settings, (c) selecting to listen to an adult telling a story in a free-play setting, and (d) intervals of stereotypy while listening to stories.

Observing responses. The third dependent variable, observing responses to the presence of adults and voices of adults, was assessed before and after the VCP. Observing responses were measured by conducting probes during three typical classroom activities: (a) one-to-one instruction, (b) group activities, and (c) free play. In the one-to-one instructional setting, the teacher instructed the participant according to his or her individualized progress in the curriculum. In the group setting, the participant sat with his or her peers during tabletop activities, such as playing with blocks, puzzles, and looking at books. In the free-play setting, the participant played with toys or chose books to read in the toy area with no demands from the teacher. We assessed the observing responses by presenting 10 different target antecedents. Table 3 lists the 10 antecedents that were probed in each of the three settings. Each type of probe was conducted twice, resulting in a total of 60 probes before VCP and 60

probes after VCP. A correct response was defined as the child orienting (i.e., looks at or turns in the direction of the adult when presented with an antecedent. If the participant oriented toward the voice or person performing the action for one second or more, an observing response was scored as present, otherwise it was scored as absent.

Selecting to listen to an adult telling a story. During the 5-min pre- and post-VCP probe sessions for selecting to listen to an adult tell a story, the teacher sat in a chair in the toy area with several small chairs in front of her. One peer was always seated in front of the teacher during the pre- and post-VCP probe sessions. No book was present; rather, the teacher began telling a story from memory in an animated voice. The participant was at no time prompted or given directions to sit or attend. Instead, the participant had the choice of sitting with the teacher and listening or selecting any other activity in the classroom. At all times throughout the probe sessions, the participant had access to all toys, activities, and materials typically available in the classroom.

During the story probe, data were collected on two target behaviors, (a) listening to an adult telling stories and (b) the emission of stereotypy. Selecting to listen was defined as the participant remaining seated in a chair facing the adult and orienting or turning toward the speaker, without emitting vocal stereotypy. A 5-s whole-interval recording system was used to record listening, in which each interval was scored as correct if the participant selected to listen for the entire 5-s interval. If at any time during the interval, the child walked away, oriented away from the speaker, engaged in stereotypical behavior, or got up from his or her seat, the interval was scored as incorrect. Vocal stereotypy was defined as the participant emitting a vocal sound with no apparent verbal function. A 5-s partial-interval recording system was used to record vocal stereotypy. Any occurrence of vocal stereotypy, however brief, resulted in stereotypy being scored as present for that interval. The data were graphed as the numbers of intervals of listening to an adult tell a story out of the total possible 60, 5-s intervals and partial interval occurrences of stereotypy.

Rate of acquisition of listener objectives. The second dependent variable, the rate of acquisition of listener instructional objectives, was defined as the number of instructional trials required to master listener curricular objectives during regular instruction before and after the implementation of the VCP. A listener objective was defined as behavior under the discriminative control of speech (Pistoljevic, 2008). For the purposes of this study, the terms *listener responses* or *listener objectives* are used to describe participant responses to the teacher's spoken command.

A listener objective was considered mastered when the participant consistently responded as a listener to the teacher's instructions with a minimum of 90% accuracy across two consecutive 20-trial instructional sessions. In order to compare the rates of acquisition of listener instructional objectives for participants A and B, we compared 1,000 learn units of instruction (50 instructional sessions or lessons) before and after the VCP. Due to a time constraint for Participant C, we compared 500 learn units (25 instructional sessions) before and after the VCP. We tallied the numbers of mastered listener objectives within the 1,000 or 500 learning opportunities and calculated mean learn units to criterion by dividing the number of instructional trials by the number of mastered listener objectives.

Table 2 lists the listener curricular programs that were part of the instruction for each participant before and after the intervention. During the intervention, all listener instruction ceased until the VCP was completed, at which point, listener instruction was reintroduced. Instructional objectives taught in the pre-intervention sessions differed from those taught in the post-intervention sessions to avoid cumulative learning effects, although the objectives were in the same domain. All instructional trials met the criterion for learn units, which consisted of the following events. Prior to presentation of the target stimulus, the child was attending, the stimulus presented was unambiguous, and the teacher did not emit prompts such as looking at the correct stimulus or position prompts. Then, the child was given an opportunity to respond (an intratrial response time), and all responses to the learn unit

Table 2
Listener Instructional Programs

Participant	Listener programs	Examples of objectives
A	Object identification	Point to _____ (spoon, doll, block)
	Shape identification	Point to _____ (star, heart, circle)
	Color identification	Point to _____ (red, blue, yellow)
	Picture identification	Point to _____ (dog, fire truck, apple)
B	Eye contact	Look at me (1 s, 2 s)
	Body part identification	Point to ____ (own arm, nose, foot)
	Deliver specified items	Give me ____ (object on table, across room)
	Respond to name	Call participant's name (1:1 setting, across room)
C	Number identification	Point to ____ (4, 9, 15)
	Color identification	Point to ____ (pink, purple, green)
	Follow vocal directions	Stand up, clap hands, jump

presentation from a teacher resulted in the delivery of a known reinforcer for correct responses or correction delivered by the teacher. Knowledge of what constituted a known reinforcer was based on extensive experience with teaching the participants in the school. The correction required the student to repeat the correct response while attending to the target antecedent stimulus, and the corrected response was not reinforced (Albers & Greer, 1991; Bahadourian, Tam, Greer, & Rousseau, 2006; Emurian, Hu, Wang, & Durham, 2000; Greer, 1994; Greer, 2002; Greer & McDonough, 1999; Ingham & Greer, 1992; Selinske et al., 1992).

Independent Variable: Acquisition of Conditioned Reinforcement for Listening to Recordings of Voices

Voice conditioning protocol (VCP). The independent variable in this study was acquisition of conditioned reinforcement for listening to recorded voices, as determined by preference probes in which the participant had the option to continuously depress either a button that resulted in voices or another button that did not result in voices. During VCP, we paired preferred items with recorded voices in training sessions until the participants chose to depress the switch that

Table 3
Observing Conditions Assessed Across Three Settings

Opportunity	Antecedent for observing response	Distance
1	His/her name was called in a moderate but detectable volume	0.5–1.5 meters
2	His/her name was called in a moderate but detectable volume	1.5–2.5 meters
3	He/she was given a 1-step direction in a moderate but detectable volume	0.5–1.5 meters
4	He/she was given a 1-step direction in a moderate but detectable volume	1.5–2.5 meters
5	An adult spoke to another child in a moderate but detectable volume	0.5–1.5 meters
6	An adult spoke to another child another child in a moderate but detectable volume	1.5–2.5 meters
7	An adult re-arranged the child's materials on the desk	NA
8	An adult removed the child's materials from the desk	NA
9	An adult entered the room speaking in a moderate but detectable volume	NA
10	An adult entered the room but did not speak	NA

resulted in voices in the two-button preference probes (Greer & Ross, 2008). Thus, the VCP consisted of (a) training sessions, and (b) two-button preference probes. In baseline, a preference probe was conducted in the absence of prior training sessions. The timing of subsequent preference probes was dependent on performance in training sessions.

The materials used for the VCP included a tape recorder and a cassette tape containing recordings of familiar persons (i.e., parents, siblings, and teachers) reading stories, two blue buttons, 7.5 cm in diameter, data collection forms, and a timer. The blue buttons were pressure switches that could be used to activate the tape recorder when connected to its input jack. The tape recording played when the button was depressed, stopped immediately when the participant removed his or her hand from the button, and restarted when the button was depressed again. Only one button was used during training sessions, but two buttons were used during preference probes. The button used during training sessions was connected to an input jack of the tape recorder and produced the recorded voices when depressed. During preference probes, only one button was connected to the input jack. The other, inactive button was connected to an output jack of the tape recorder and did not produce sound when it was depressed. The participants observed the experimenters insert tapes into the recording device and they could see the attachment of the switches to the tape recorder.

In addition to these materials, preferred edibles were present during training sessions, but not during the preference probes. Edible stimuli were selected individually for each participant, based on the observation that they had functioned as reinforcers during various instructional activities in the school setting.

In training sessions, the recorded voices were paired with preferred stimuli by delivering the latter contingent on the participant's pressing a button to produce the former. Each training session consisted of 20 instructional trials that will be referred to as *pair-test* trials, because each trial consisted of a pairing component and a test component. In these trials, only one button was placed on the table in front of the participant. The button remained on the table throughout the entire session. The target behavior was defined as holding down the button such that the recorded voices could be heard, without emitting vocal stereotypy. Vocal stereotypy consisted of non-contextual words and vocal sounds. During the pairing component of a pair-test trial, the experimenter delivered edibles or gentle physical touch contingent upon the continuous occurrence of the target behavior. Two or three instances of edibles or gentle physical touch were delivered per trial. Vocal praise was not used as a reinforcer because it might have conflicted with listening to the voices recorded on the tape. Reinforcement was not delivered in the first or last second of the interval. If at any point during the pairing component, the participant emitted stereotypy or did not depress the switch, the pairing trial was restarted immediately once stereotypy or incompatible responding ceased. Following a successful pairing component (one in which there was no stereotypy and the participant listened to the voices) and only after a successful component, a test component was conducted. During the test component, no consequences were delivered for pressing the button. In cases where the child did not depress the button immediately, the participant was prompted to do so. The experimenter recorded the pair-test trial as correct if in the test component, the target behavior occurred for the entire criterion duration. If at any time during the test component, the participant emitted stereotypy or did not depress the switch, the pair-test trial was scored as incorrect, and the pairing component of the next pair-test trial began.

The initial criterion duration for pair-test trials was 5 s. This meant that (a) a test component was conducted only when the participant pressed the button continuously for at least 5 s in the preceding pairing component, and (b) a pair-test trial was scored as correct only if the participant pressed the button continuously for at least 5 s in the test component. Training sessions continued with the 5-s criterion duration until the percentage of correct trials reached 90% or more in two consecutive sessions. Once this criterion was reached, a preference probe (described below) was conducted. Preference sessions were usually done on the following day, or in the afternoon if the criterion was

met in the morning. The purpose of the preference probe was to determine whether the pair-test trials had, in fact, conditioned the tape recording of voices as a reinforcer for choosing to depress the switch. If the participant did not pass the preference probe, training sessions resumed, and the criterion duration for pair-test trials was increased by 5 s. When the percentage of correct trials again reached 90% or more in two consecutive training sessions, another preference probe was conducted. The cycle of training sessions with increasing criterion durations followed by preference probes continued until the participant passed a preference probe. During training, the pairing schedule remained the same, with delivery of preferred stimuli 2 to 3 times per trial, regardless of the criterion duration.

During the preference probes, two buttons were placed on the table in front of the participant, available for the participant to choose from. One button activated the player when depressed, and the other resulted in no sound. Tapes with the teachers', siblings', and parents' voices telling the stories were continually rotated between sessions, and no songs or other auditory stimuli were used. Each preference probe lasted 5 min. This period was divided into 5-s intervals for data collection purposes (a total of 60 intervals). After a variable number of intervals (ranging from 5 to 15), the experimenter rotated the positions of the buttons in view of the participant, such that the participant was required to test and select the working switch in order to continue to activate the tape player. During preference probes, two responses were recorded. The first response was listening to the stories recorded on the tape by pressing and holding down the switch that activated the voices. The second response measured was the presence or absence of vocal stereotypy. Vocal stereotypy was defined as the participant emitting a nonsensical vocal sound that had no apparent verbal function. As per the target behavior definition, listening appropriately could not occur simultaneously with vocal stereotypy. Responses were recorded as the total number of 5-s intervals during a 5-min probe. Appropriate listening responses were measured using whole-interval recording, in which the participant depressed the switch for the entire 5-s interval without emitting stereotypy. Had the participants depressed both buttons simultaneously, that would have been recorded as not depressing the voice button. But this did not occur. Stereotypy was measured using partial interval recording, in which stereotypy was recorded if it occurred at least once during the 5-s interval (Greer et al., 1985), in which case listening was also scored as absent. Criterion for the preference probes was set at one probe in which the participant listened to voices during at least 90% of the intervals. When this criterion was attained, the VCP was considered completed and post-VCP probes for the dependent variables commenced. Otherwise, training session continued with increased criterion duration, followed by another preference probe. Neither reinforcement nor corrections were delivered during the probe sessions.

Interobserver Agreement (IOA)

A second and independent observer recorded data simultaneously with the experimenter during learn unit presentations, story listening probes, observing probes and preference probes to assess interobserver agreement (IOA). We combined the measures of preferences for voices and choice of listening to stories to calculate IOA. For the two assessments the percentage of IOA was calculated on an interval-by-interval basis by dividing the numbers of agreements by the total number of agreements and disagreements and multiplying this number by 100. For Participant A, during pre- and post-VCP sessions for selecting to listen to an adult read and selecting to listen to stories on audiotape, IOA was assessed across 50% of the story listening and voice preference sessions with a mean of 95% agreement (range, 85% to 100%). For Participant B, IOA was assessed across 67% of the story listening and voice preference sessions, with a mean of 95% agreement (range, 90% to 100%). For Participant C, IOA was assessed similarly in 33% of the sessions, with a mean of 92% (range, 88% to 100%).

IOA for learn unit presentations, during listener instruction, was assessed by an independent observer who used the Teacher Performance Rate Accuracy Protocol (TPRA) (Ingham & Greer, 1992). The TPRA simulta-

neously assess not only IOA for the experimenter's accuracy for recording but also the participants' responses and fidelity of the experimenter's trial-by-trial implementation of instructional trials that meet the criterion for learn units. A check mark is recorded for an accurate antecedent presentation and an encircled check mark for an error, the participant's response is recorded as plus or minus, the consequence is an R for an accurate reinforcement operation and a C for an accurate correction operation by the experimenter. Errors in the reinforcement result in an encircled R and errors in the consequence as an encircled C. A correct presentation was scored for the experimenter when the child was attending to the antecedent, the antecedent was unambiguous, the experimenter did not provide prompts erroneously, the participant had an opportunity to respond, correct responses were reinforced with a known reinforcer, incorrect responses resulted in the participant emitting a corrected response that was not reinforced. Fidelity was calculated by dividing the sum of accurate presentations by the total numbers of presentations. In all sessions for which fidelity of presentation was conducted, the procedural reliability or accuracy of presentations of learn units was 100%.

IOA for the experimenter's accuracy for recording the participants' responses to learn units was calculated by dividing the number of agreements between the experimenter and independent observer by the combined total of agreements and disagreements and multiplying that number by 100. For Participant A, IOA was assessed during 33% of the instructional sessions during baseline with a mean of 98% (range, 95% to 100%). For Participant B, IOA was assessed during 50% of the instructional sessions during baseline with a mean of 98% (range, 95% to 100%). For Participant C, IOA was assessed during 10% of the instructional sessions with a mean of 100%. In all sessions for which IOA was conducted the procedural reliability or accurate presentations of learn units was 100%.

We used the mean duration-per-occurrence IOA for the observing probes. Observing responses were timed as a duration using a digital timer by both the observer and experimenter. IOA was calculated by totaling the number of point-to-point agreements on duration for each response (i.e., either the same or not same numbers of seconds were recorded) and dividing by the total number of responses recorded and multiplying by 100. For Participant A, IOA was collected for 90% of the observing probes with a mean of 98% agreement (range 85%, 100%). For Participant B, 96% IOA (range 80%, 100%) was collected for 83% of all the observing probes. For Participant C, 100% IOA was collected for 90% of the observing probes.

Experimental Design

We used a delayed non-concurrent pre- and post-intervention design (Greer et al., 2007; Pistoljevic & Greer, 2006), that also may be characterized as a multiple-probe variation of the Horne and Baer (1978) design logic, to compare the numbers of intervals participants selected to listen to an adult tell a story and adult voices on the tape and rates of stereotypy before and after the VCP. We also measured the numbers of learn units to criteria or the rate of acquisition of the listener instructional objectives and the observing responses to adults voices and presence before and after the VCP. Prior to the implementation of the VCP, measures for the dependent variables were obtained for (a) rate of acquisition of listener instructional objectives, (b) observing responses to voices and adult presence across three settings, (c) selecting to listen to an adult telling a story in a free-play setting, and (d) intervals of stereotypy while listening to stories. Then, all of the participant's instructional programs ceased with the exception of mand instruction and programs to teach appropriate play. During this time, the VCP was implemented until the criterion for listening to the tapes of voices was met in the preference probes. Following the mastery of the voices as conditioned reinforcers for listening to the tapes, all the participants' new instructional programs were introduced and the probes for the dependent variables were repeated. First, the VCP was implemented for Participant A. When the VCP was completed, post-intervention probes were conducted. At this time, the pre-intervention probes were conducted for Participant B, followed by the implementation of the VCP. While the post-intervention probes were conducted for Participant B,

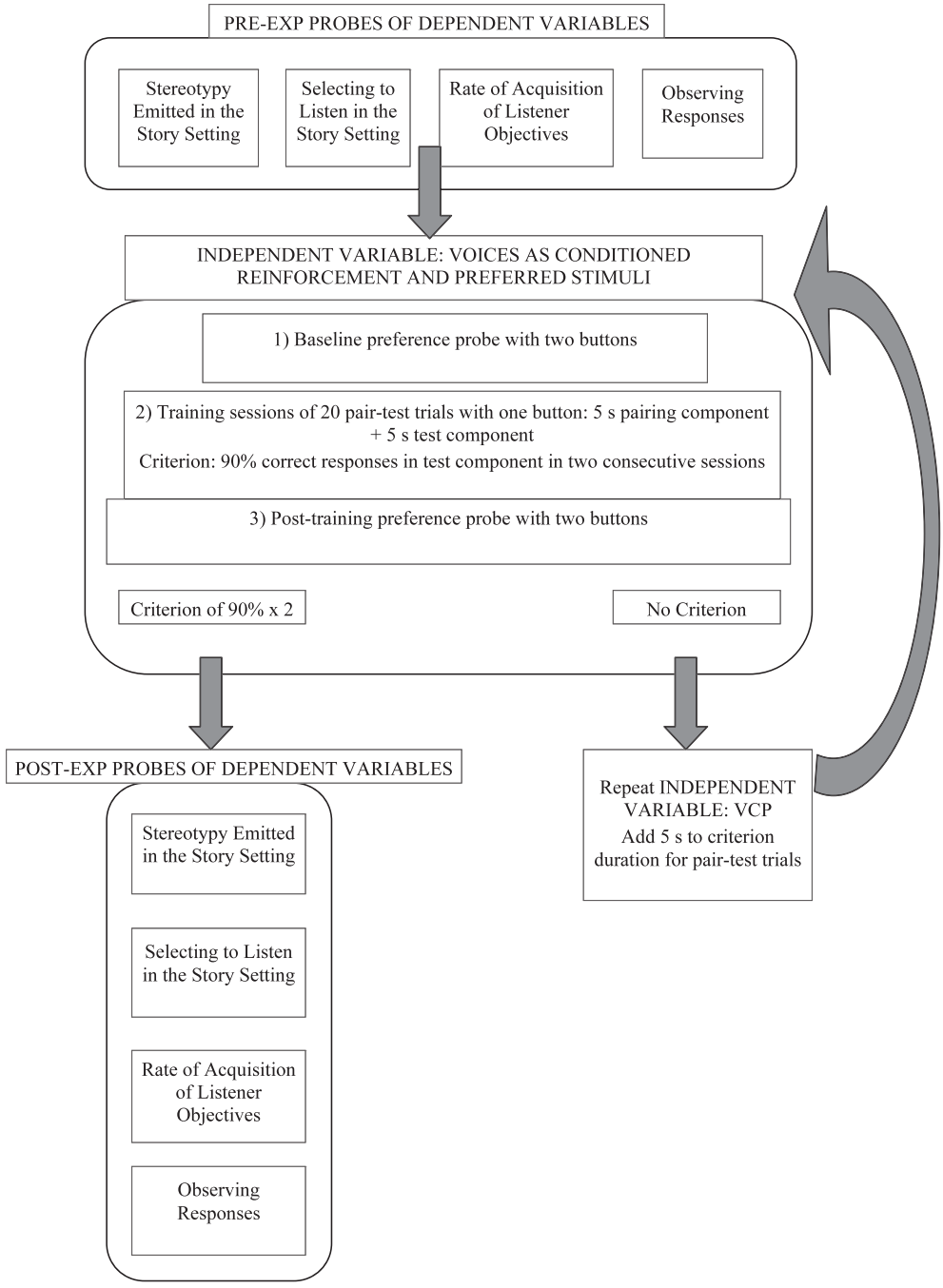

Figure 1. Figure 1 shows the sequence of components of the experimental design.

the pre-intervention probes were conducted for Participant C, followed by the implementation of the VCP and post-intervention probes. Figure 1 shows the sequence of components of the experimental design.

RESULTS

We first describe measures of the implementation of the independent variable (the VCP) that consisted of the data from the

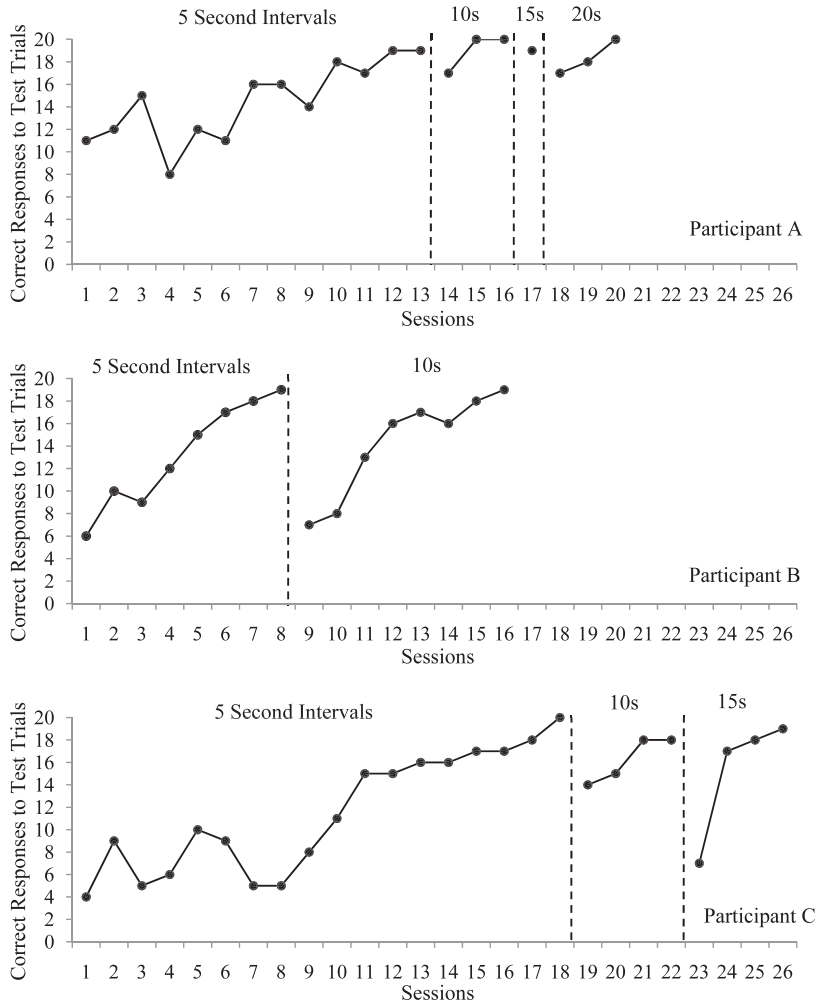

Figure 2. Figure 2 shows numbers of correct responses in the test component of pair-test trials in 20-trial training sessions for Participants A, B, and C during the implementation of the VCP stimulus-stimulus pairing procedure.

preference probes, which were interpreted as acquisition of conditioned reinforcement for listening to recordings of adult voices. Following that, we describe the pre- and post-VCP measures of the dependent variables.

Implementation of the Independent Variable

Training sessions. Figure 2 shows the data collected in training sessions during the VCP for all participants. Participant A met criterion after 13 sessions in the first phase, in which the criterion duration of pressing the button was 5 s. He met the criterion after 3 sessions in the second phase with a 10-s criterion duration, 1 session in the third, 15-s phase, and 3 sessions in the fourth, 20-s phase. Participant B met criterion after 8 sessions in the 5-s phase, and 8 sessions in the 10-s phase. Participant C met criteria after 18 sessions in the 5-s phase, 4 sessions in the 10-s phase, and 4 sessions in the 15-s phase.

Preference probes. Figure 3 shows the attainment of the criterion for acquiring conditioned reinforcement for recorded voices by the three participants. During the pre-VCP preference probe, Participant A depressed the button that produced recorded voices throughout the duration of 6 out of 60

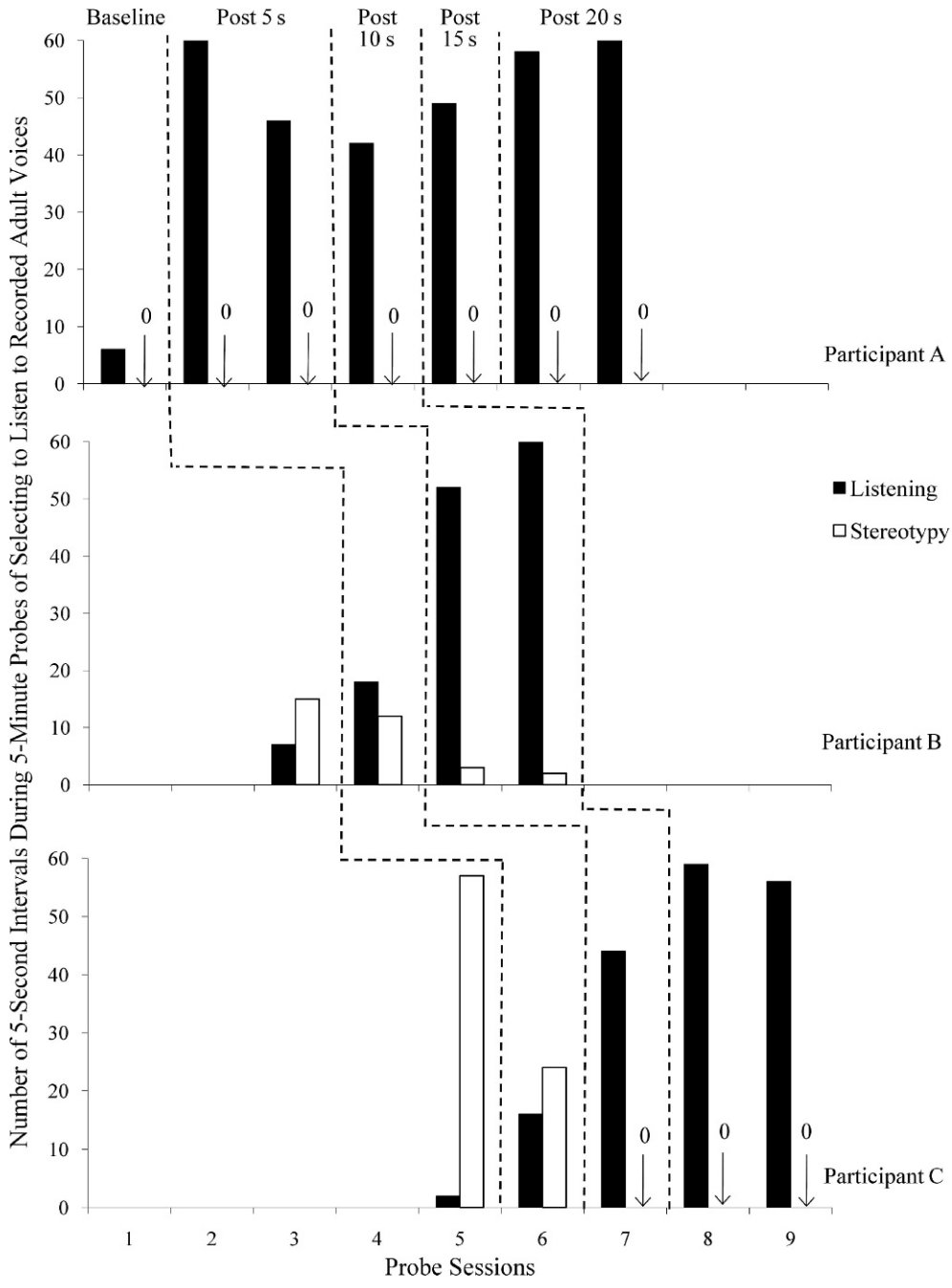

Figure 3. Figure 3 shows the numbers of 5-s intervals out of 60 in which participants A, B, and C selected to listen to recorded adult voices during two-button preference probes before and after each phase of the pair-test training procedure leading to the conditioning criterion.

5-s intervals. When he achieved criterion in the 5-s training sessions, another preference probe was conducted in which he selected to listen for 60 out of 60 intervals. For this participant, an instructional history of variability indicated that two consecutive sessions at 90% or better (54/60) should be set as criterion. This participant frequently

required consecutive sessions at criterion levels to demonstrate maintenance in his instruction in the school. So to ensure that the results were consistent across the various voices and recorded stories, the probe was repeated. In the second probe, he selected to listen for 46 out of 60 intervals and based on his prior instructional history in instruction and we extended the conditioning time to 10-s to ensure that the treatment was implemented. Following the 10-s pairing procedure, participant A selected to listen for 42 out of 60 intervals, and following the 15-s procedure she listened for 49 out of 60 intervals. Following the 20-s pairing procedure, he selected to listen for 58 out of 60 intervals, and 60 out of 60.

During the pre-VCP preference probe, Participant B selected to listen to recorded adult voices for 5 out of 60 5-s intervals. After achieving criterion for the 5-s training sessions, she selected to listen for 18 out of 60 intervals. Following 10-s training sessions, she selected to listen for 52 out of 60 intervals and 60 out of 60 intervals respectively.

For Participant C, during the pre-VCP probe, he selected to listen to recorded voices for 2 out of 60 intervals. Following 5-s training sessions, he selected to listen for 16 out of 60. Following the 10-s training sessions, he selected to listen for 44 out of 60 intervals. Following the 15-s training sessions, he selected to listen for 59 out of 60 intervals, and 56 out of 60 intervals. All three participants met the criterion for achieving conditioned reinforcement for voices. Different participants required different intervals of pairing training sessions to meet the criterion for the attainment of conditioned reinforcement for voices as determined by the preference assessment. Once the independent variable or the attainment of conditioned reinforcement for voices was present, post-VCP measures of the dependent variables were obtained.

Participants B and C emitted vocal stereotypy in their pre-VCP probes. For Participant B the intervals of stereotypy decreased slightly after the 5-s phase, and to 2 and 1interval of stereotypy respectively, in the first and second probe after the 10-s phase. Participant A emitted 58 intervals of stereotypy in the pre-VCP probe, 22 intervals after the 5-s phase, and no intervals of stereotypy in the post-15-s and post-20-s phases.

Dependent Variables

Rate of acquisition of listener objectives. Figure 4 shows the mean numbers of learn units required by the participants to master listener instructional curricula before and after the VCP. Table 4 shows the actual number of criteria achieved by each participant before and after the VCP. This was a measure of the effect of conditioning voices as a reinforcer on rate of learning of instructional objectives requiring the participants' discriminative responding to the speech of teachers. Before the VCP, Participant A required a mean of 250 learn units to reach criterion during instruction involving listener responses. Following the VCP, the mean numbers of learn units decreased to 55.5. Before the VCP, Participant B required a mean of 500 learn units to achieve an objective. Following the VCP, the mean decreased to 76.9. Before the VCP, Participant C required a mean of 167 learn units per objective. Following the VCP, the mean decreased to 50.

Observing responses. Data for the 10 observing responses were combined into a total number of observing responses across three settings with two opportunities for each response in each setting, resulting in 60 opportunities. The results are displayed for the 3 participants in Figure 5. Prior to the VCP, Participant A had 2 observing responses out of 20 in the one-on-one setting, 4 out of 20 in the group setting, and 7 out of 20 in the free-play setting, for a total of 13 observing responses out of 60 opportunities. Participant B had 3 observing responses out of 20 in the one-on-one setting, 0 out of 20 in the group setting, and 4 out of 20 in the free-play setting, for a total of 7 observing responses out of 60 opportunities. Participant C had 0 observing responses out of 20 in the one-on-one setting, 0 out of 20 in the group setting, and 0 out of 20 in the free-play setting, for a total of 0 observing responses out of 60 opportunities.

Following the VCP, Participant A had 17 observing responses out of 20 in the one-on-one setting, 15 out of 20 in the group setting, and 17 out of 20 in the free-play

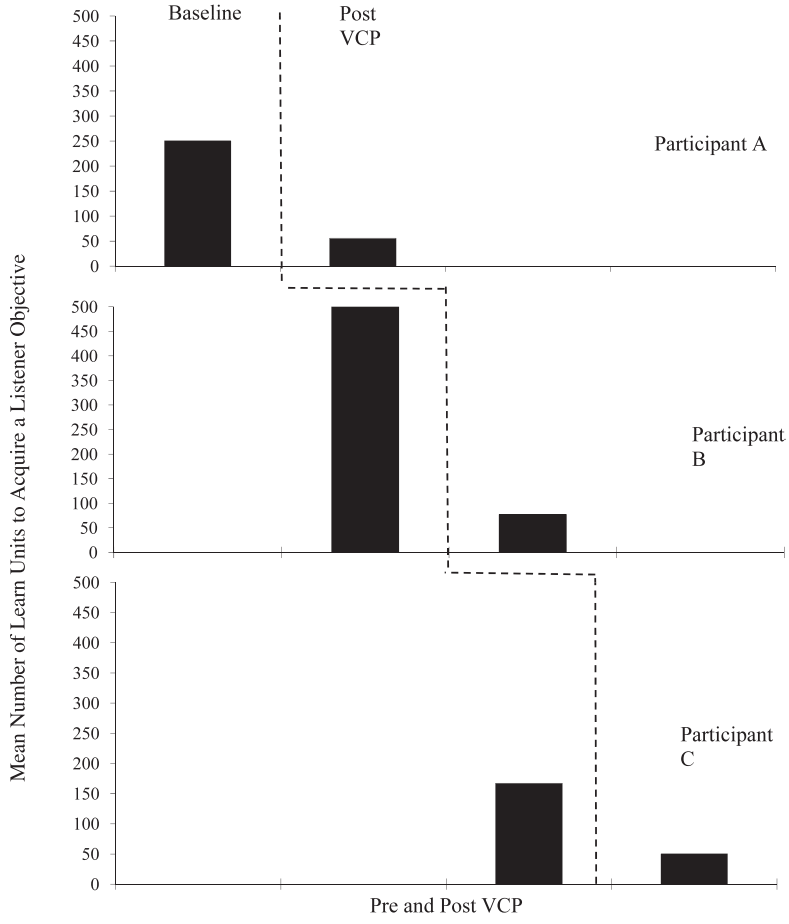

Figure 4. Figure 4 shows the participants A, B, and C's mean numbers of instructional trials (i.e., learn units) required for the achievement of educational listener objectives before and after voices were conditioned as reinforcers for listening to audiotaped voices.

setting, for a total of 49 observing responses out of 60 opportunities. Participant B had 10 observing responses out of 20 in the one-on-one setting, 17 out of 20 in the group setting, and 13 out of 20 in the free-play setting, for a total of 40 observing responses out of 60 opportunities. Participant C had 1 observing response out of 20 in the one-on-one setting, 0 out of 20 in the group setting, and 1 out of 20 in the free-play setting, for a total of 2 observing responses out of 60 opportunities. Participants A and B showed relatively strong effects, while Participant C showed no effect.

Table 4
Learn Units to Criteria for Listener Operants

	A		B		C	
Participant	Pre-VCP	Post-VCP	Pre-VCP	Post-VCP	Pre-VCP	Post-VCP
Total learn units	1,000	1,000	1,000	1,000	500	500
Criteria achieved	4	18	2	13	3	10
Mean learn units to criterion	250	55.5	500	76.9	167	50

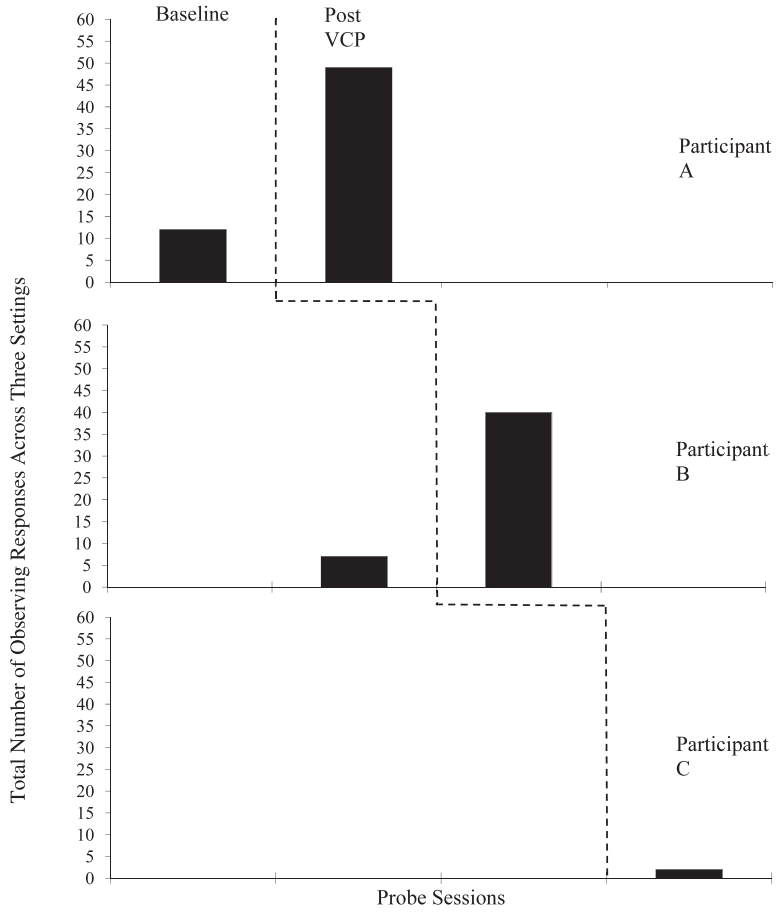

Figure 5. Figure 5 shows the numbers of observing responses to adult voices and the presence of adults by participants A, B, and C across three classroom before and after the VCP out of total 60 opportunities, 10 in each setting conducted two times. This figure shows our dimensional measure of the children's ''awareness'' of adults' presence and speech sounds before and after the voice conditioning.

Listening to an adult tell stories in toy area (Figure 6). In the pre-VCP probe, Participant A selected to listen to an adult tell stories for 3 out of 60 5-s whole intervals. Following the completion of the VCP, he selected to listen for 60 out of 60 intervals. No stereotypy was observed in either probe. Participant B chose to listen to stories in the toy area for 7 out of the 60 intervals in the pre-VCP probe and 21 out of 60 intervals in the post-VCP probe. Participant B emitted stereotypy for 21 out of 60 intervals in the pre-VCP probe, and in the post-VCP probe, for 2 of the 60 intervals. Participant C listened to stories in 2 out of 60 intervals in the pre-VCP probe. In the post-VCP probe, he listened for 57 out of 60 intervals. During the pre-VCP probes, Participant C emitted stereotypy for 7 of the 60 intervals, but emitted no stereotypy during the post-VCP probes. The data in Figure 6 show strong effects for Participants A and C, and weak or negligible effects for Participant B for this measure.

DISCUSSION

All students demonstrated a significant decrease in learn units (i.e., instructional trials that met the requirements for learn units) required to master educational objectives involving listener responses following the establishment of conditioned reinforcement for recorded voices. Their rate of learning accelerated. Participant A and C

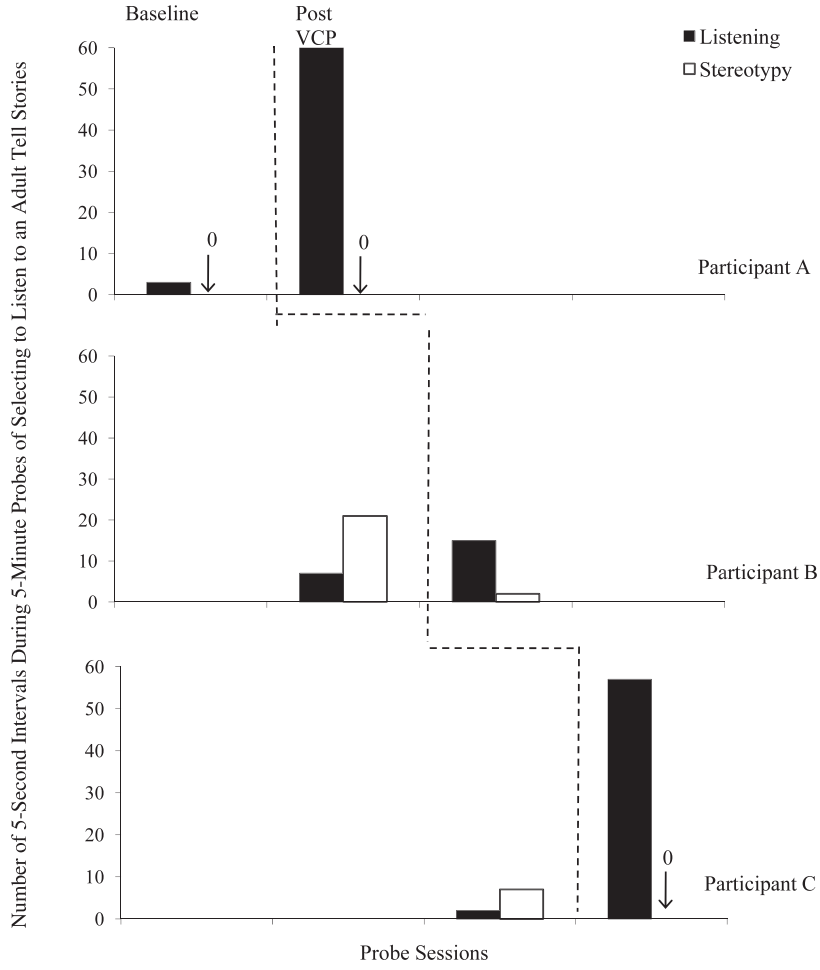

Figure 6. Figure 6 shows the numbers of 5-second intervals out of 60-test intervals in which participants A, B, and C selected to listen to an adult tell stories in a free play setting, while toys and other competing stimuli were simultaneously available. The figure also shows the numbers of intervals containing stereotypy during the listening to story probes, before and after the conditioning of voices as reinforcers. The figure shows the children's preference for and continued listening to stories.

increased their choice of listening to stories being told, while Participant B did not. Participants A and B demonstrated significant increases in observing responses in the classroom settings, while participant C did not. In summary, the VCP affected measures of learning for all of the participants, choosing to listen to stories in a free-play setting for two of three participants, and awareness of two of three of the participants.

The data support the notion that conditioned reinforcement for voices improves children's attention to vocal instruction, which is consistent with the VBDT hypothesis that establishment of the reinforcing value of voices may be a prerequisite for learning to respond to vocal instructions. Measures of awareness and preference for listening to stories were supportive of this hypothesis also, but not as strongly as the rate of learning measure. It is tenable to suggest that conditioned reinforcement for voices is a behavioral developmental cusp for the listener foundations to becoming verbal, at least for children similar to the participants in this study. That is, we hypothesize that the onset of conditioned reinforcement for attending to voices acted to (a) accelerate the participant's

rate of learning (i.e., decrease the number of learn units required to master instructional objectives) and (b) make it possible for the participants to come in contact with stimuli they did not before (i.e., children's awareness of the presence of others). Thus, the acquisition of conditioned reinforcement for voices appears to meet the criteria for a developmental cusp according to Rosales-Ruiz and Baer (1996).

According to VBDT, the acquisition of conditioned reinforcement for voices is a prerequisite for learning to respond to vowel-consonant properties of speech discriminatively. While a single study cannot affirm this theory, the present data provides support for it. In order to fully test this assumption, controlled experiments would need to be conducted from birth through the acquisition of certain verbal foundational cusps. It is possible that children with language delays as severe as the children who participated in this experiment are very different from typically developing children. However, our data do suggest that it is possible for conditioned reinforcement for voices to be a foundational cornerstone in very early language development. Pereira-Delgado et al. (2009) reported similar effects of conditioned reinforcement for 2-dimensional stimuli on acquisition of match-to-sample responding with visual stimuli and Tsai and Greer (2006) reported similar findings for conditioning looking at books on rate of learning textual responses.

From the applied perspective, the procedure shows considerable utility. The amount of instruction required for all children to achieve educational objectives requiring listener responses decreased drastically. This means that considerably less instructional time was required for these children to learn listener objectives than before. This is a procedure that we have used quite extensively in our work with numerous children who had similar characteristics as the participants in this study. In most cases we have found similar outcomes, and the procedure has decreased instruction time needed to master curriculum-based instruction. We think that this procedure and similar ones, described in the introduction for other observing responses, simply makes it possible to make progress with children like these, when other procedures require extensive numbers of learn units involving prolonged shaping procedures

It is possible that the mastery of educational objectives may advance more quickly when conditioned reinforcement for observing responses to stimuli, that are associated with discrimination instruction, occurs first. Certainly basic science findings by Dinsmoor (1983), and applied findings by Pereira-Delgado et al. (2009), Keohane et al. (2008), and Tsai and Greer (2006) support this notion. While considerably more research is needed to confirm this, the existing findings do seem promising.

There are several limitations in the current study. First and foremost is the lack of an effect on one out of three dependent measures for Participants B and C. The rate of learning measure seems robust and findings across the studies have replicated this. The measure of choice to listen to stories may need additional work. There may be other prerequisites for listening to stories that Participant A and B had and Participant C did not have. For the awareness measure (i.e., observing adults and orienting to their presence or voice), Participant A and C may have had the prerequisites and B may not have had them, or the orienting responses across the classroom settings may not have been the best dimension of measurement. The definition of the volume level of the tests of the reinforcing control of voices for orienting responses is not as operational as it should be. The voices were louder than the ambient noise level in the classroom and we thought the volume level was easily discernible by individuals with normal hearing. It was important that the volume level not be so loud that it was the novelty of the volume rather than the control for voices that resulted in orienting responses. What we sought is something like the ''cocktail phenomenon'' described in some psychological literatures. Clearly, measurement procedures should be developed further.

Second, although we interpret the data from the preference probes of the VCP as evidence that the pair-test training procedure resulted in the conditioning of voices as reinforcers, a potential limitation is that the baseline preference assessment did not provide a stringent control for the effects of

simply being exposed to the stimuli that were paired during training. A more stringent baseline condition would have controlled for the presentation of stimuli in the pair-test procedure, and included additional baseline data points for at least some participants to assess effects of repeated exposure. Prior laboratory studies involving control groups that received repeated listening to music without pairings did not result in increases in selection of the music (Greer, Dorow, & Hanser, 1973; Greer, Dorow, Wachhaus et al., 1973). However, this might not be the case for voices, and future research should address this limitation.

Another limitation is that there was only 1 pre-VCP and 1 post-VCP probe for listening to stories in the free play setting. More probe sessions would have improved the believability of our findings. In the awareness settings there were numerous observations in many instructional settings in the pre- and post-VCP assessments. Also, the rate of learning measure included extensive numbers of sessions before and after the VCP. However the probes in the story settings should have been more extensive. Future studies should address these limitations.

One of the reviewers raised the possibility that the procedure may have conditioned other auditory stimuli as well as voices. This is a possibility since the general awareness data show that the children oriented to other sounds, such as the door opening when an adult entered the classroom. Of course, the tests of whether the voices alone were conditioned as reinforcers cannot be determined by the procedures that we used in the test for the effectiveness of the pair and test procedure on preference. It is possible that sounds in general were conditioned and that children might choose any sound had the option been available. Had the instrumentation used in the VCP been more sophisticated we could have tested whether other auditory stimuli had attained conditioned reinforcement value. A program of research in the 1970s, involving several hundred participants, used instrumentation that measured laboratory-controlled free operant responses of participants to several auditory stimuli and included white noise as a control (Greer, 1981). However, none of those several hundred participants chose white noise except for one child who was found to have a hearing deficit. The instrumentation involved the use of cumulative recorders, automatic-switching devices and relays, and light sensitive keys that the participants used to initiate and maintain the auditory stimuli and this instrumentation was too unwieldy for use in classrooms for applied purposes. However, it is now possible to develop software programs for these procedures to be used with widely available computers. Thus, it may soon be possible to have this kind of precision available in applied settings, allowing the measurement and conditioning of visual and auditory stimuli.

One of the useful outcomes of this procedure was the actual process for conditioning reinforcers for observing responses. Several studies over four decades have repeatedly shown this is a viable and valuable procedure. Researchers have reported that preference can be taught and preferences can be changed (Greer et al., 1985; Hanley, Iwata, Roscoe, Thompson, & Lindberg, 2003; Hanley, Tiger, Ingvarsson, & Cammilleri, 2009; Miguel, Carr, & Michael, 2002; Nuzzolo-Gomez et al., 2002; Sundberg et al., 1996; Williams, 1994). Clearly, being able to do this is of exceeding value in educational applications of behavior analysis, and perhaps in other applications by psychologists and speech therapists. The ability to condition reinforcers for engaging in subject matter activities provides an operational goal in education relative to teaching children to develop commonly agreed on values and one that is obtainable and measurable (Greer, 1980, 1981).

Over the last few decades, a great deal of research had been devoted to preference assessment (e.g., Clevenger & Graff, 2005; DeLeon et al., 2001; Roane, Vollmer, Ringdahl, & Marcus, 1998). However, rather than finding preferences as the only resort, there are now procedures to condition reinforcers for learning and performance as well as various observing responses. Once conditioned reinforcers are acquired, the child's environment changes and preferences change. Changing the environmental control in the form of adding conditioned reinforcers may be long-term solution to many so-called behavior problems. After all, it is the

reinforcers that select out the behavior, directly conditioning new reinforcers is at least a possible, if not better, solution. At least from the perspective of teaching new operants, the process of conditioning of reinforcers for observing responses related to the discriminations to be taught is building a credible evidence base. Once the child is under the control of observing the stimuli associated with the visual, auditory, olfactory, gustatory, or kinesthetic stimuli that are to be discriminated, learning proceeds quickly. Using prompts may not always result in transfer of stimulus control and conditioning stimuli as reinforcers for observing responses may obviate the need for prompts in some or many cases.

As to its role in dealing with stereotypy, it is possible that the conditioning of new reinforcers for observing certain stimuli and objects for play, is an approach to the treatment of stereotypy that deals with a possible fundamental source for many types of stereotypy for some children. We think that the findings of the initial study (Greer et al., 1985) and subsequent replications and extensions suggest that stereotypy is a function of a paucity of conditioned reinforcers, at least in some cases. That is, when there are few conditioned reinforcers, individuals are likely to engage in stereotypy for the automatic reinforcement; increasing the numbers of reinforcers for observing and engaging in behavior is possibly a preferable solution to the problem. It should be noted that the conditioning of reinforcers for play and observation is different than teaching children to play appropriately with toys. While the latter may result in the acquisition of the stimuli associated with play as conditioned reinforcers, that outcome is a collateral effect. We hypothesize that the conditioned reinforcement effect is the desired outcome and direct conditioning is preferable to teaching play behaviors. Perhaps if the reinforcers for play are present learning to play appropriately is likely to occur incidentally or can be taught more quickly. It should be noted, however, that in the present study, Participant A did not have stereotypy to begin with, and C had very little in the story setting. The big change that was observed in stereotypy was for participant C in the preference probes.

While the contribution of our findings to verbal behavior developmental theory is formative at this point, the applied utility of the procedure is robust. Conditioned reinforcement is a valid explanatory construct (Greer, Dorow, & Hanser, 1973; Williams, 1994) and there is growing evidence based on its utility for pedagogy and as an alternative treatment for stereotypy.

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